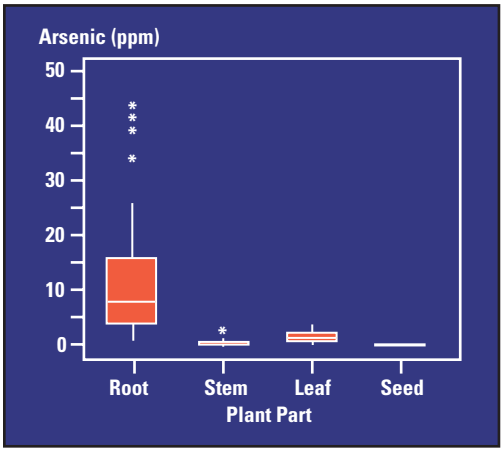
USGS
science for a changing world

Plants and Lichens as Indicators of Atmospheric Deposition

USGS is studying the pathways used by atmospheric contaminants in National Parks using plants and lichens.

Hypogymnia physodes, one of the most common lichens in the world, is shown here growing on birch bark.

The natural world is being continuously exposed to atmospheric emissions from human activities. Even remote, supposedly pristine areas like Isle Royale National Park in Lake Superior and areas of Alaska are exposed. The magnitude of emissions from industries, urban areas, and power generation facilities, combined with the atmosphere's ability to transport emissions great distances leads to this high degree of widespread exposure. Elements such as mercury and lead are found in ecosystems in national parks throughout the U.S. These are toxic to many organisms as they are passed up food chains. One USGS scientist is conducting long-term studies of the geographic extent and degree of contamination by these elements and several others in National Parks.



Statistical analysis of arsenic deposits in wild rice (Zizania palustris) from northern Wisconsin shows the highest concentrations in the roots.

In the terrestrial world, deposition of air pollutants occurs to foliage of plants and the soil surface. Rooted plants, therefore, may take up elements through leaves directly, or through roots in the soil. Mobility of these elements inside plants is determined physiologically; therefore analysis of plant parts elucidates the pathways of deposition. Arsenic, for example, is highly toxic, and is usually confined to roots. Analysis of soils is also needed to determine the element concentrations normally present. These studies also help determine if there are naturally high levels of certain elements present from geologic anomalies. For example, high levels of mercury are found in some plants in Yellowstone National Park due to naturally occurring emissions from geothermal features.

Lichens are small, symbiotic plants that grow on trees, rocks, and soils. They have no roots and are totally dependent on the atmosphere for their nutrition. They receive no sustenance from their hosts, just physical support. Thus, elevated concentrations of certain elements in lichens are a sure sign of atmospheric deposition. Studies of the presence and absence of sensitive lichen species, and of element concentrations in their tissues, are ways of discovering atmospheric impacts in an area. Some studies are performed along transects downwind of point sources (tall stacks, for example) to determine the amount and geographic distribution of fallout from the source. Transplants of lichens from pristine to polluted areas are done to determine the continued presence of atmospheric pollutants. Common species such as *Hypogymnia physodes*, that are found in many localities, are used for sampling element deposition because of their widespread distributions. Nutritional elements are commonly studied, in addition to elements known to be emitted anthropogenically, such as lead, mercury, cadmium and chromium.

Since 1982, studies like these have been conducted in 42 national parks and refuges. Approximately 3000 lichen samples representing 50 or more species have been collected from around 400 localities in these areas. These samples have been measured for 22 chemical elements, providing an estimated 50,000 data points for

analysis. The data are archived for use by other researchers and for comparisons over time. This research helps to document the effects of air pollution on park and refuge vegetation and assists managers by alerting them to potential air pollution problems. Work on additional parks and refuges (and continuation of efforts in currently sampled areas) will continue.

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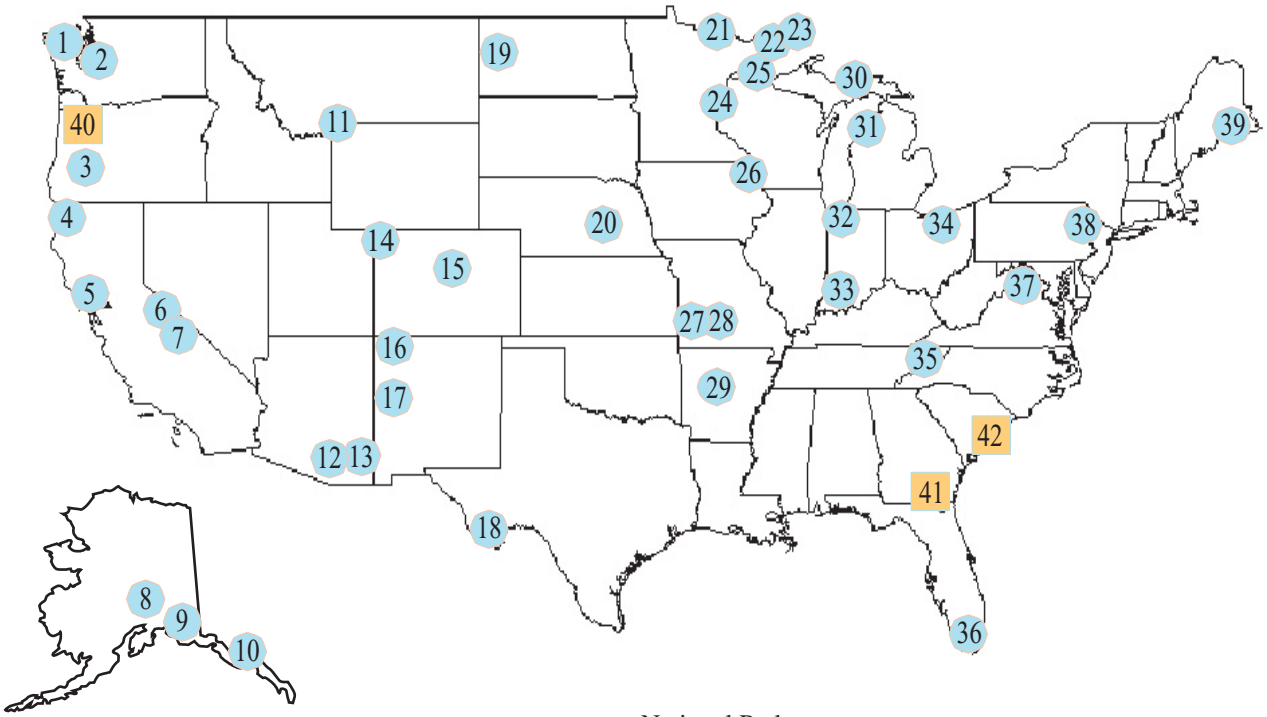
Department of Interior Lands Studied for Lichen Chemistry



National Park*s*

Acadia, ME	39	Klondike Gold Rush, AK	10
Apostle Islands, WI	25	Lincoln Boyhood, IL	33
Big Bend, TX	18	Mount Rainier, WA	2
Chaco Culture, NM	16	Olympic, WA	1
Chiricahua, AZ	13	Oregon Caves, OR	3
Cuyahoga Valley, OH	34	Pictured Rocks, MI	30
Delaware Water Gap, PA	38	Point Reyes, CA	5
Denali, AK	8	Redwood, CA	4
Dinosaur, CO	14	Rocky Mountain, CO	15
Effigy Mounds, IA	26	Saint Croix, MN & WI	24
El Morro, NM	17	Saguaro, AZ	12
Everglades, FL	36	Sequoia, CA	7
George Washington Carver, MO	28	Shenandoah, VA	37
Grand Portage, MN	22	Sleeping Bear Dunes, MI	31
Great Smoky Mountains, TN	35	Theodore Roosevelt, ND	19
Homestead, NE	20	Voyageurs, MN	21
Hot Springs, AR	29	Wilson's Creek, MO	27
Indiana Dunes, IN	32	Wrangell-St. Elias, AK	9
Isle Royale, MI	23	Yellowstone, WY	11
Kings Canyon, CA	6		

National Wildlife Refuges

Cape Romain, SC	*42*	*William L. Finley, OR*	*40*
Okefenokee, GA	*41*		